Surgical Procedures in Nonagenarians

STEPHEN L. MICHEL, MD; LESLIE STEVENS, MD; PAMELA AMODEO, MA, *and* LEON MORGENSTERN, MD, *Los Angeles*

During the hospital course of 225 nonagenarian patients who underwent 285 major operations—80% on the general, vascular, orthopedic and urologic services—overall morbidity was 37% and mortality 7.5%. The 100 emergency operations were associated with a higher morbidity and mortality rate. Nonsurvivors were more likely to have associated cardiac or cerebral medical conditions, higher utilization of intraoperative invasive hemodynamic monitoring and greater use of surgical intensive care units. Compared with all surgical patients, the nonagenarians were admitted twice as often to the surgical intensive care unit, required twice the number of hospital days, underwent intraoperative hemodynamic monitoring twice as frequently and incurred 200% greater hospital charges. We conclude that with careful evaluation and management, a nonagenarian patient presenting with a surgical condition can safely undergo necessary operative procedures.

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Surgical intervention in an elderly patient has been the subject of many reviews, but nonagenarians as a class have received scant attention.[1] The landmark age of 90 years still evokes awe and wonderment in our society; we felt it worthwhile to study whether patients of this age and older can successfully withstand major surgical procedures. In this review we analyze our experience with 225 surgical patients aged 90 years and older admitted to the surgical service during a 3½-year period.

Patients and Methods

We reviewed 388 inpatient hospital records, analyzing operative procedures and postoperative courses in 225 nonagenarian patients who had undergone 285 major operations. The patient records were analyzed for the following factors: age, sex, surgical diagnosis, operative procedure, designation as an emergency procedure, anesthetic risk classification, duration and type of anesthesia, associated medical problems, use and type of intraoperative invasive hemodynamic monitoring, intraoperative complications, in-hospital morbidity and mortality, surgical intensive care unit use and length of preoperative and postoperative stay.

Coding of diagnosis and procedures was in accordance with terminology in the *International Classification of Diseases.*[2]

Results

The age range of patients in this study was 90 to 102 years, with an average age for both men and women of 92.1 years. Men comprised 42% of the group, women 58%.

Table 1 depicts the major surgical services to which these patients were admitted. Orthopedics accounted for the largest group, both in percent of operations (33%) and percent of emergencies (52%). The urologic and general surgical services were next in frequency of admissions, with the remainder scattered among other surgical specialties.

Table 2 shows the disease categories for which operations were done.

Hospital Care

Nonagenarian patients constituted 1.3% of all admissions to the noncardiac surgical intensive care units, where their average length of stay was 2.8 days. The average hospital stay for this group was 16.9 days, in contrast to the length of stay for all patients, which averaged 7.2 days. The average patient charge for the nonagenarians was $15,575; for all surgical patients it

From the Department of Surgery, Cedars-Sinai Medical Center, Los Angeles.
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Reprint requests to Stephen L. Michel, MD, Department of Surgery, Cedars-Sinai Medical Center, PO Box 48750, Suite 8215, Los Angeles, CA 90048.

was $5,400. The total cost for the group of 225 nonagenarians was in excess of $3.5 million.

Anesthesia

Classification of anesthetic risk was according to the standardized criteria of the American Society of Anesthesiologists. None of these patients was in the class I or most favorable group. The outcome according to class of anesthetic risk is shown in Table 3.

The most common anesthetic technique was general anesthesia (47%); spinal or epidural anesthesia accounted for 28.9% of anesthetics administered. The remainder consisted of 24.2% of patients operated on under local anesthesia. The average duration of anesthesia was two hours.

TABLE 1.—*285 Operations by Specialty in 225 Nonagenarians*

Specialty	Percent of Operations	Percent of Emergencies*
Orthopedics	33	52
Urology	21	2
General	17	24
Thoracic	11	8
Vascular	9	10
Eye	4	1
Other	5	3

*N = 100

TABLE 2.—*Operations in Nonagenarians by Disease Category*

Disease Category	Number of Operations*	
Geriatric		
Heart block	32	
Arteriosclerosis	30	
Benign prostatic hypertrophy	25	
Cataract	9	
TOTAL	96	(33%)
Trauma		
Hip fractures	84	
Other	10	
TOTAL	94	(32%)
Natural Disease		
Hernia	16	
Bladder/urethra	13	
Biliary	4	
Small bowel obstruction	4	
Peptic ulcer	4	
Colon	3	
Miscellaneous	10	
TOTAL	54	(19%)
Neoplasm		
Bladder	13	
Prostate	8	
Colon	8	
Breast	6	
Skin	4	
Other	9	
TOTAL	48	(16%)

*7 minor operations are included.

Hemodynamic Monitoring

Monitoring by arterial line or Swan-Ganz catheter (or both) was not as frequent as might be expected, either during operation or postoperatively. Only a third of this group had invasive hemodynamic monitoring. As might be expected, hemodynamic monitoring was most frequent in the nonsurvivors (80%) because these were the most critically ill subset of the nonagenarians.

Morbidity and Mortality

The overall morbidity and mortality statistics for those patients in three major specialities are shown in Table 4. Nearly a third of patients undergoing elective operation had some complication; over half of the patients undergoing emergency operation had a major complication. The operative mortality for the entire group was 7.5%. As might be expected, it was twice this number for emergency procedures.

Discussion

Longevity in Biblical times was described thus in the 90th Psalm: "The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labour and sorrow . . ." In 1980 the life expectancy for men was 70, and for women 77. In that census year, 4% of the US population (9.4 million) was aged 75 years and older; in the year 2000, 5% (13.5 million) of the population will consist of people 75 years and older.[3] No separate figures are available for the group we are

TABLE 3.—*Survival According to Anesthetic Risk*

American Society of Anesthesiologists Class	Survivors Percent	Nonsurvivors Percent
I*	0	0
II	7.7	0
III	46.3	31.8
IV	45.3	54.6
V	0.7	13.6

*Class I represents the lowest risk.

TABLE 4.—*Morbidity and Mortality in Three Major Specialties*

Specialty	Entire Series		Elective Operations		Emergency Operations	
	Morbidity Percent	Mortality Percent	Morbidity Percent	Mortality Percent	Morbidity Percent	Mortality Percent
Orthopedic	56	9	59	9	54	10
General	43	12	33	7	54	17
Vascular	28	16	27	0	30	40
Total Morbidity for Series 37.0%						
Total Mortality for Series 7.5%						

discussing, namely those aged 90 and older. Surely the number must be small, very probably a fraction of 1%.

Health care for the aged is an issue of increasing concern and complexity.[4-9] The 11% of the population older than 65 years is responsible for 26% of all days of care in community hospitals and a third of all health care expenditures. The hospital admission rate for persons older than 75 years is 54% higher than that of the group between 65 and 74 years. Hospital expenditures for the population older than 65 years is 3½ times the rate for persons younger than 65 years.

This then is the general picture of American health care in the aged in this decade. What conclusions can we draw about the rare nonagenarian who undergoes an operation? The conclusion is obvious that this group can withstand an operation at a respectable mortality rate. The mortality rate for those aged 90 and older in this series (7.5%) is practically identical with that quoted for octogenarians by Reiss and co-workers.[10] The life expectancy for nonagenarians is three additional years of life, as compared with that for octogenarians, which is five years.

Other reports of surgical experience in the elderly have focused on malignant diseases,[11,12] gastrointestinal operations,[13] hip fractures,[14] inguinal herniorrhaphy,[15] breast cancer,[16] abdominal aortic aneurysm,[17] colorectal tumors,[18] head and neck tumors[19,20] and specific details of intraoperative care.[21-23] More comprehensive reviews, similar in scope to the present series, serve to put our results in context with other authors' experience.[1,11,24-28]

Our study specifically identifies the frequent utilization by these nonagenarian patients of the surgical intensive care unit and their substantial length of stay in the hospital, two factors not reported in the other referenced series. It is helpful to be aware of the distribution of these elderly patients among the surgical specialties, the types of illnesses with which they present, their relative cumulative use of such resources as intensive care unit beds and operating rooms and the total cost of their care.

A surgeon managing these very elderly patients must recognize the physiologic alterations that occur in all organ systems as part of the aging process. Compared with a young adult (age 30), an elderly person (age 75) has remaining only 43% of maximum breathing capacity, 69% of glomerular filtration rate, 70% of cardiac output and 84% of basal metabolic rate.[29] In addition to these decreases in major organ system functions, hepatic metabolism is altered, resulting in a tendency for hyperglycemia to develop and causing changes in the effectiveness of standard doses of commonly used drugs.[30] These age-related physiologic changes cause nonagenarian patients to be extremely intolerant of any injudicious clinical assessment or management of volume depletion, fluid overload, pulmonary support, renal perfusion or metabolic abnormality, as reported by Del Guercio and Cohn.[23] Surgeons must carefully evaluate and prepare nonagenarians who present with a surgical condition. They must recognize and treat coexistent medical disorders and monitor hemodynamic and other vital functions during and after operation.

This study shows that patients 20 to 30 years older than previously described high-risk elderly surgical patients can safely undergo necessary surgical procedures. These nonagenarian patients, like the "one-hoss shay,"[31] have not only lived a long life but still possess sufficient resilience to tolerate major operations, though they can deteriorate quickly when one or more serious complications occur in the postoperative period.

". . . [A]nd that's the reason, beyond a doubt, that a chaise *breaks down,* but doesn't *wear out.*"[31]

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